

Dan Kaufman
Director, Information Innovation Office

An analytical framework for cyber security



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An analytical framework for cyber security

November 2011





What we hear.



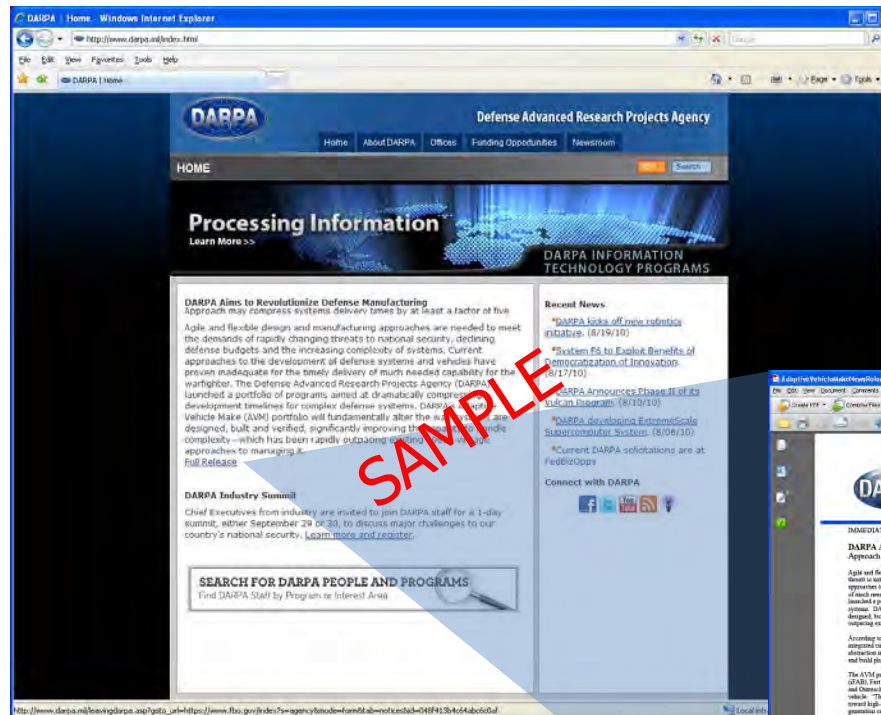
Attackers penetrate the architecture easily...

Goal

- Demonstrate asymmetric ease of exploitation of DoD computer versus efforts to defend.

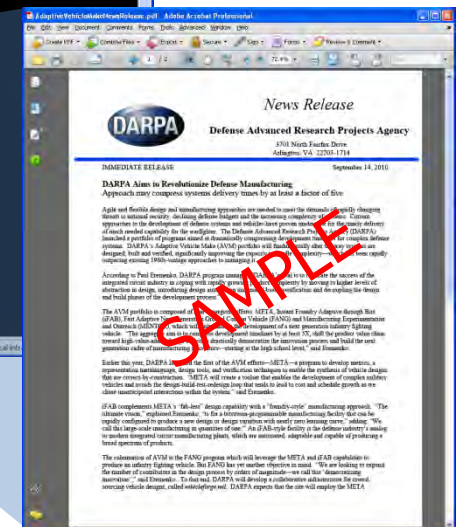
Result

- Multiple remote compromises of fully security compliant and patched HBSS[†] computer within days:
- 2 remote accesses.
- 25+ local privilege escalations.
- Undetected by host defenses.



Hijacked web page

Infected .pdf document



HBSS Workstation
Penetration Demonstration

Total Effort: 2 people, 3 days, \$18K

HBSS Costs: Millions of dollars a year for software and licenses alone (not including man hours)

[†] = Host Based Security System (HBSS)



Users are the weak link...



Finweb = Jane123
DTS = 123Jane
PKI = JaneA123
DiskCrypt = Jane123A
Gmail = Jane123A



The supply chain is potentially compromised...

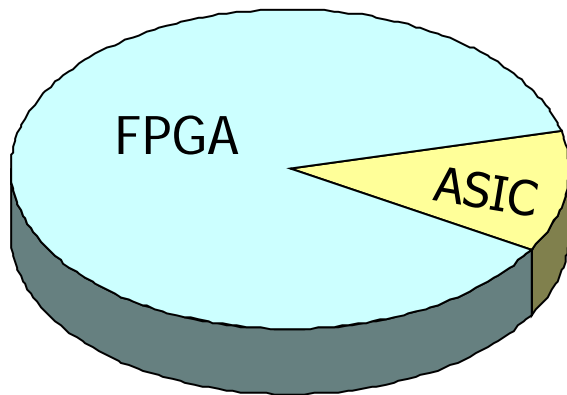
Approximately 3500 ICs.

- 200 unique chip types.
- 208 field programmable gate arrays (FPGAs).
- 64 FPGA and 9 ASIC types across 12 subsystems.

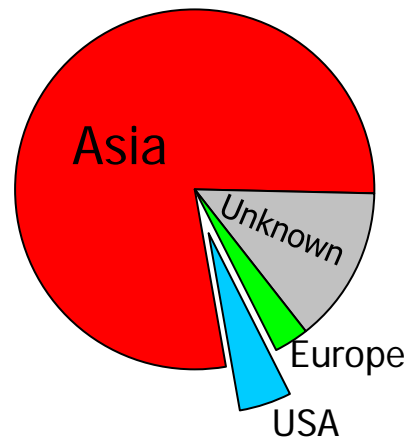
78% of FPGAs and 66% of ASICs manufactured in China and Taiwan.



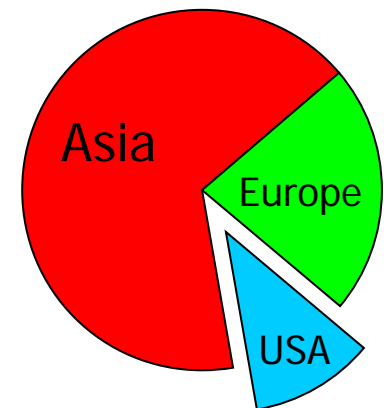
JSF FPGA & ASIC Usage



FPGA
Manufacture Location



ASIC
Manufacture Location





Our physical systems are vulnerable to cyber attacks...

A4 Nation

S

The Washington Post

SATURDAY, JANUARY 16, 2010

U.S. plans to issue official protest to China over attack on Google

BY ELLEN NAKASHIMA

The United States will issue an official protest to the Chinese government over a major espionage attack targeting Google's computer systems and rights activists' e-mail accounts that the search-engine giant said originated in China.

"We will be issuing a formal de-

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day.
The
"expres

cident" and seek an explanation, he said. The move may signal a shift for an administration that has been reluctant, according to China experts, to press sensitive issues such as human rights, lest it offend a country whose cooperation it seeks in other areas.

On Tuesday, in a rare disclosure by a major firm, Google announced that its "corporate infrastructure" had been hacked and

Google, were affected.

Google also said it will no longer filter Internet searches on its Chinese search engine, Google.cn. Although it did not directly accuse China, the Silicon Valley technology titan threatened to pull out of the country if the government does not allow it to operate uncensored. Chinese officials said that their laws ban hacking and that China's Internet is open,

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day. She is expected to allude to the incident. "When she talks about this issue, China will be one of the countries she points to," an administration official said.

"You couldn't have picked a worse company to hack if you wanted to not irritate the Americans," said James Aber and national security at the Center for Strategic International Studies. Google. The firm's chief advises President Obama with a technology, and its innovations are seen as the economy.

Officials said the administration has raised concerns about cybersecurity and Internet freedom with China before. But by formally protesting to the Chinese, the United States is elevating the issues to a new level, policy experts said. Richard N. Rose, director of the Project

said his analysis of results from a technology firm investigating the attacks suggests that they "were not state-sponsored or the work of an elite, sophisticated group such as the Chinese military."

Nonetheless, said Sophie Richardson, Asia advocacy director for Human Rights Watch, "Go-

Chinese cyber attack:
"Highly sophisticated and targeted attack" on Google corporate infrastructure (known as Aurora)

Small group of academics took control of a car using Bluetooth and OnStar. They were able to disable the brakes, control the accelerator, and turn on the interior microphone.^[1]



False speedometer reading
Note that the car is in park...

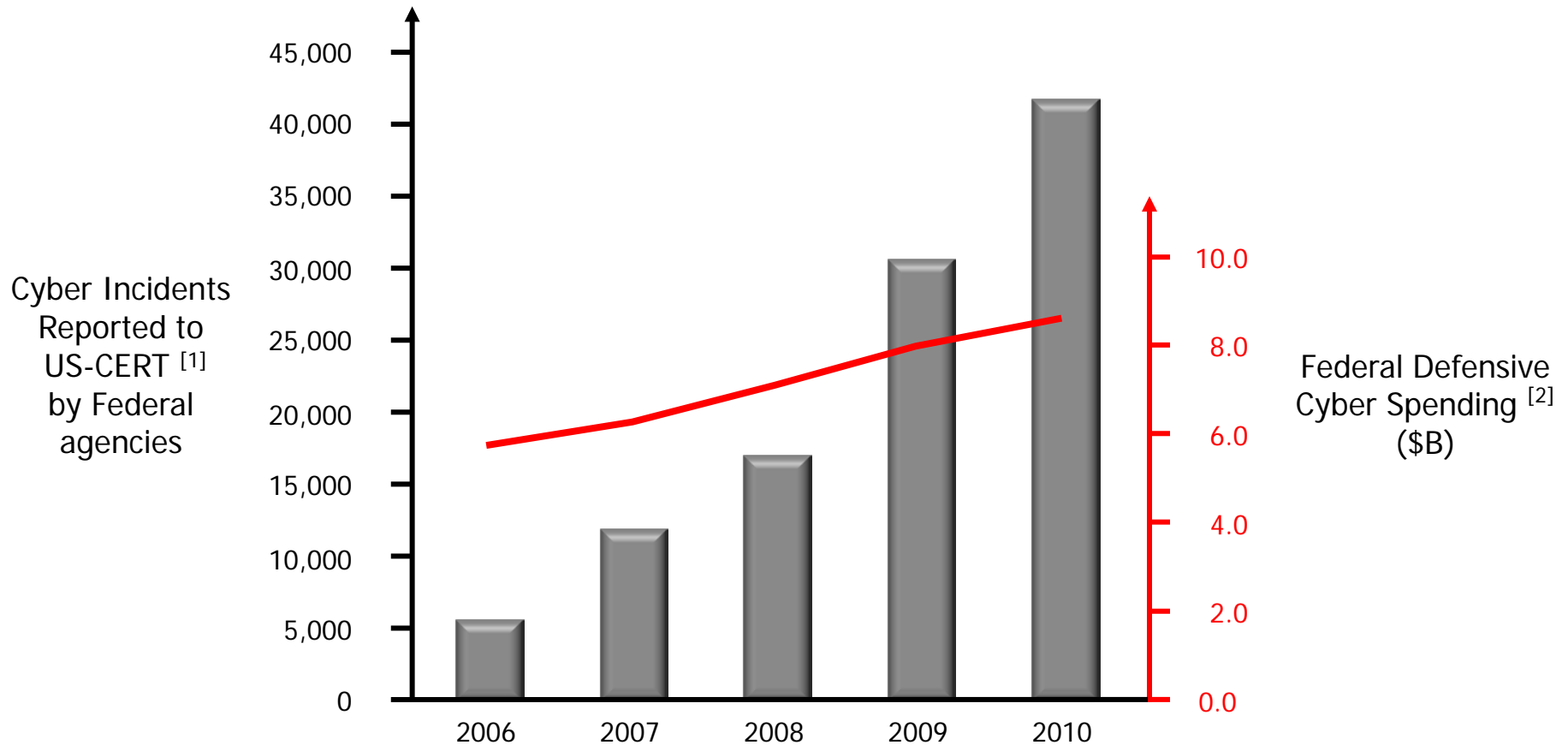
[1] K. Koscher, et al. "Experimental Security Analysis of a Modern Automobile," in Proceedings of the IEEE Symposium on Security and Privacy, Oakland, CA, May 16-19, 2010.



We are doing a lot, but we are losing ground...



Ground truth...



Federal Cyber Incidents and Defensive Cyber Spending
fiscal years 2006 – 2010

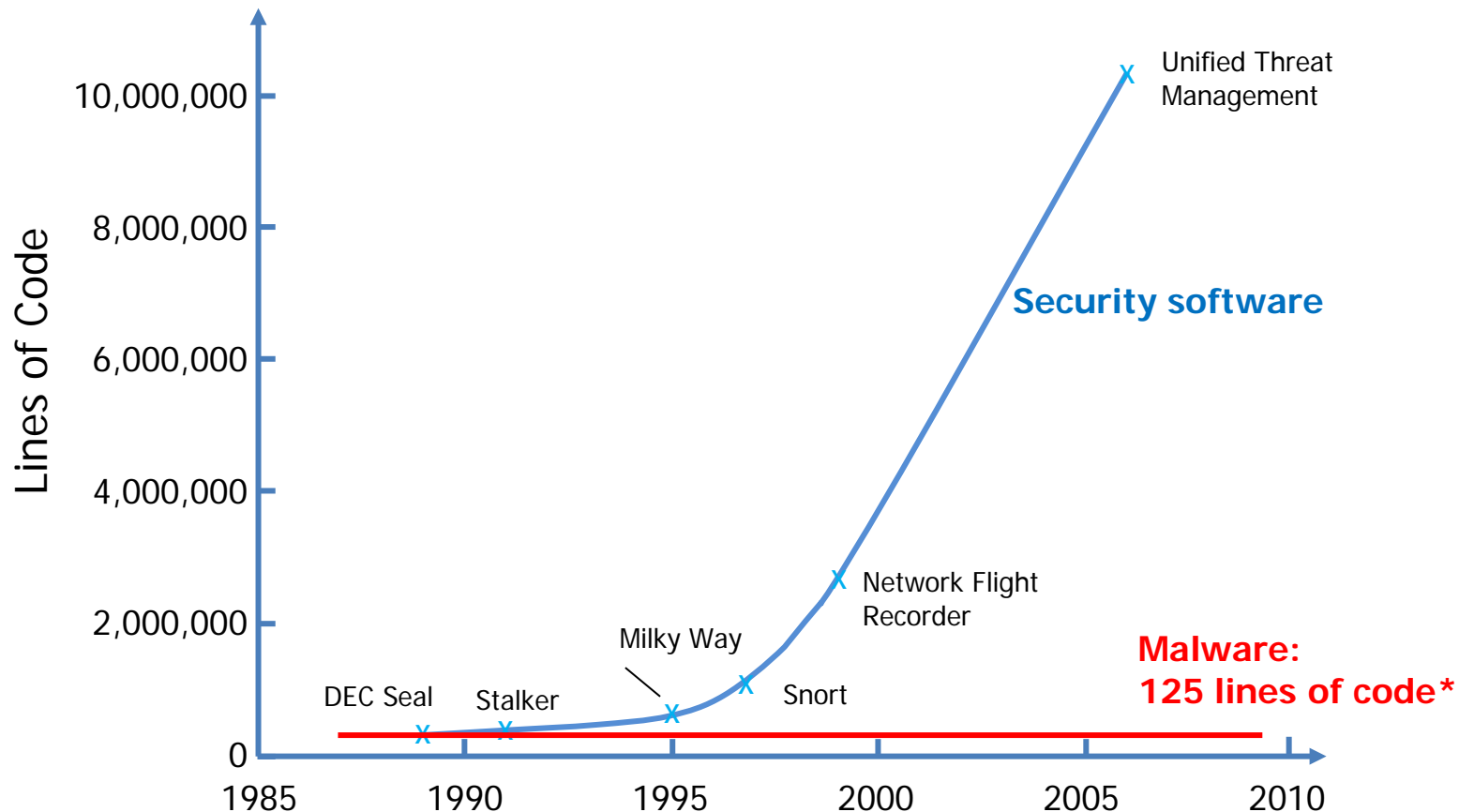
- [1] GAO analysis of US-CERT data.
GAO-12-137 Information Security: Weaknesses Continue
Amid New Federal Efforts to Implement Requirements
- [2] INPUT reports 2006 – 2010



Why?



We are divergent with the threat...

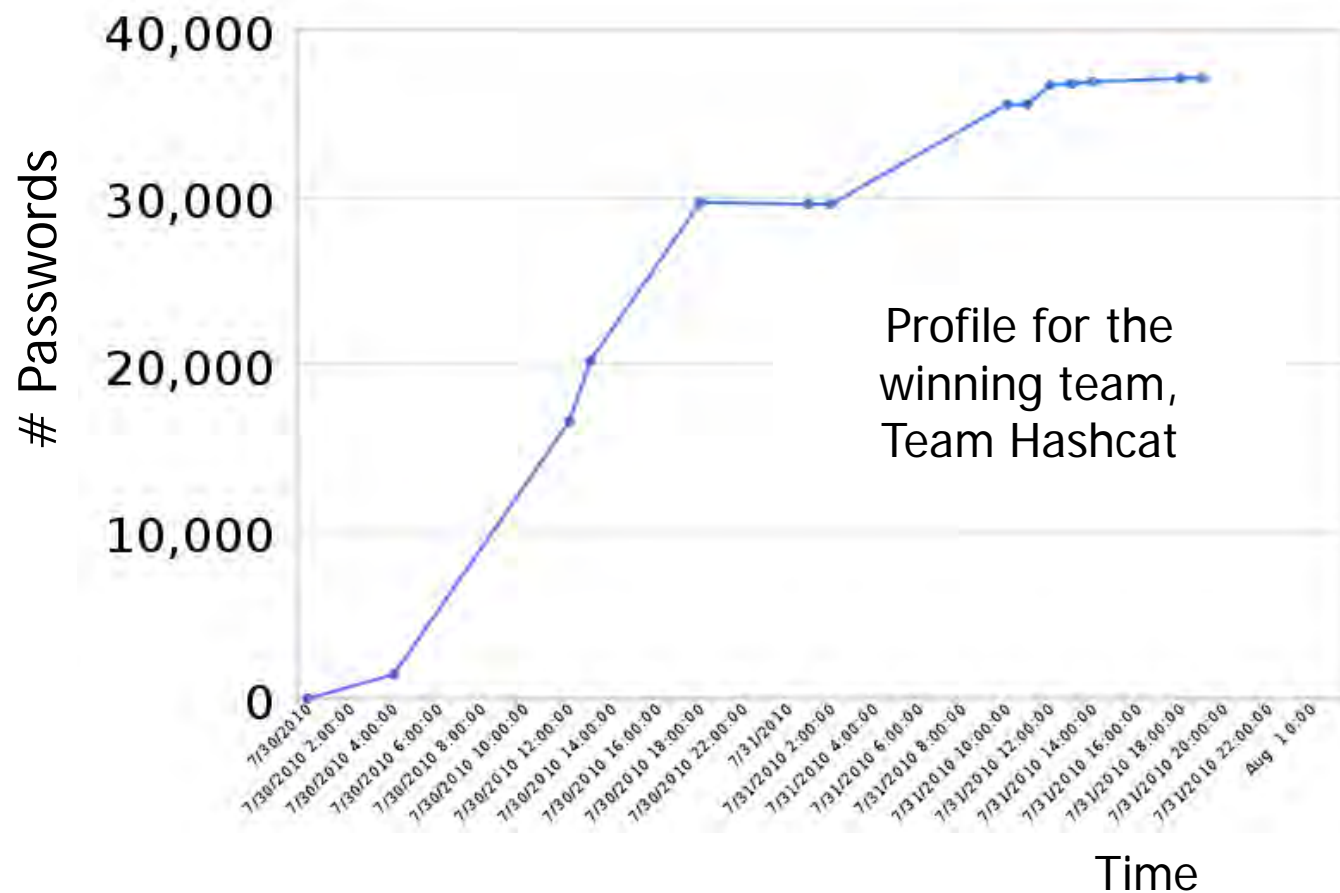


* Public sources of malware averaged over 9,000 samples (collection of exploits, worms, botnets, viruses, DoS tools)



User patterns are exploitable...

A recent Defcon contest challenged participants to crack 53,000 passwords.
In 48 hours, the winning team had 38,000.





Additional security layers often create vulnerabilities...

October 2010 vulnerability watchlist

| Vulnerability Title | Fix Avail? | Date Added |
|---|------------|------------|
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Local Privilege Escalation Vulnerability | No | 8/25/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Denial of Service Vulnerability | Yes | 8/24/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Buffer Overflow Vulnerability | No | 8/20/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Sanitization Bypass Weakness | No | 8/18/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Security Bypass Vulnerability | No | 8/17/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Multiple Security Vulnerabilities | Yes | 8/16/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Remote Code Execution Vulnerability | No | 8/16/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Use-After-Free Memory Corruption Vulnerability | No | 8/12/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Remote Code Execution Vulnerability | No | 8/10/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Multiple Buffer Overflow Vulnerabilities | No | 8/10/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Stack Buffer Overflow Vulnerability | Yes | 8/10/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Security-Bypass Vulnerability | No | 8/10/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Multiple Security Vulnerabilities | No | 8/10/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Buffer Overflow Vulnerability | No | 7/29/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Remote Privilege Escalation Vulnerability | No | 7/28/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Cross Site Request Forgery Vulnerability | No | 7/26/2010 |
| XXXXXXXXXXXXX XXXXXXXXXXXXXXXX Multiple Denial Of Service Vulnerabilities | No | 7/22/2010 |

6 of the vulnerabilities are in security software

Color Code Key:

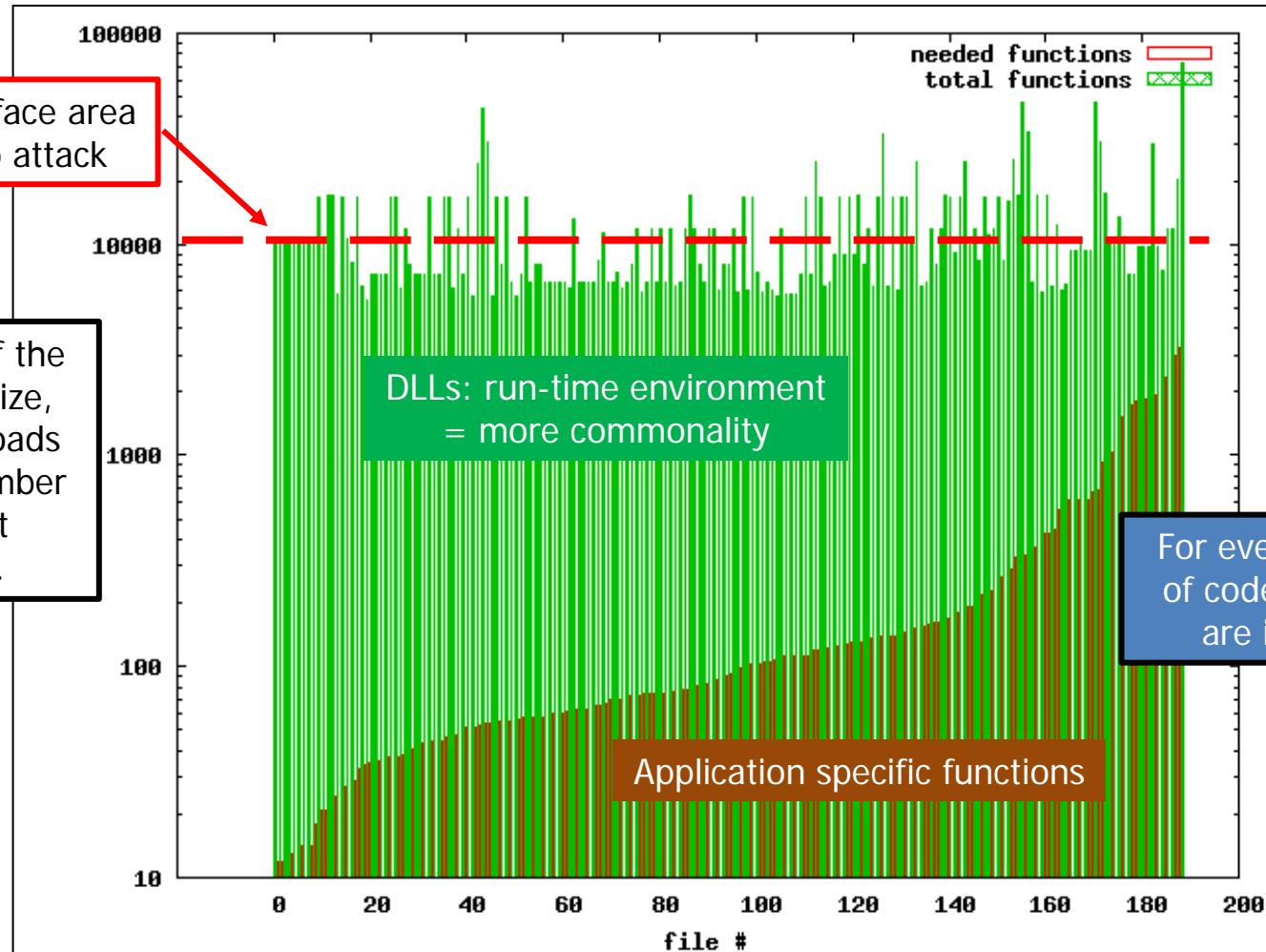
Vendor Replied – Fix in development

Awaiting Vendor Reply/Confirmation

Awaiting CC/S/A use validation



These layers increase the attack surface...





We amplify the effect by mandating uniform architectures



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

March 22, 2007

M-07-11

MEMORANDUM FOR THE HEADS OF DEPARTMENTS AND AGENCIES

FROM: Clay Johnson
Deputy Director for Management

SUBJECT: Implementation of Commonly Accepted Security Configurations for Windows Operating Systems

To improve information security and reduce overall IT operating costs, agencies who have Windows XP™ deployed and plan to upgrade to the Vista™ operating system, are directed to adopt the security configurations developed by the National Institute of Standards and Technology (NIST), the Department of Defense (DoD) and the Department of Homeland Security (DHS).

The recent release of the Vista™ operating system provides a unique opportunity for agencies to deploy secure configurations for the first time when an operating system is released. Therefore, it is critical for all Federal agencies to put in place the proper governance structure with appropriate policies to ensure a very small number of secure configurations are allowed to be used.

DoD has worked with NIST and DHS to reach a consensus agreement on secure configurations of the Vista™ operating system, and to deploy standard secure desk tops for Windows XP™. Information is more secure, overall network performance is improved, and overall costs are reduced.

Agencies with these operating systems must adopt these standards. Agencies are requested to submit their response to fmua@omb.eop.gov. To improve our security requirement, please contact the Technology at (202)395-1000.

To improve information security and reduce overall IT operating costs, agencies who have Windows XP™ deployed and plan to upgrade to the Vista™ operating system, are directed to adopt the security configurations developed by the National Institute of Standards and Technology (NIST), the Department of Defense (DoD) and the Department of Homeland Security (DHS).



The US approach to cyber security is dominated by a strategy that layers security on to a uniform architecture.

We do this to create tactical breathing space,
but it is not convergent with an evolving threat.



Technology is not the only culprit... nor the only answer.



Economics matter...

There are multiple choices for addressing the supply chain vulnerability:

- Resort to manufacturing all chips in trusted foundries.
This is not feasible or sustainable.
- Screen all chips in systems critical to National Security or our economic base.
Despite recent advances in screening technology, this is not feasible, affordable, or sustainable at the scales required.

| Process | Trusted Design and Untrusted FAB | | | Untrusted Design ASIC | | | Untrusted Design FPGA | | |
|----------------------------------|-------------------------------------|-----------|-----------|--------------------------|-----------|-----------|--------------------------|-----------|-----------|
| | Phase 1 | Phase 2 | Phase 3 | Phase 1 | Phase 2 | Phase 3 | Phase 1 | Phase 2 | Phase 3 |
| P_D | 90.0% | 99.0% | 99.9% | 80.0% | 90.0% | 99.0% | 90.0% | 99.0% | 99.9% |
| P_{FA} | 10^{-3} | 10^{-5} | 10^{-7} | 10^{-3} | 10^{-4} | 10^{-6} | 10^{-3} | 10^{-5} | 10^{-6} |
| # of Transistors Evaluated | 10^5 | 10^6 | 10^8 | 10^5 | 10^6 | 10^8 | 10^5 | 10^6 | 10^7 |
| Time to Evaluate* | 480 H | 240 H | 120 H | 480 H | 240 H | 120 H | 480 H | 240 H | 120 H |

- 3,500 IC's on the F-35
- Single FPGA = 400 million transistors
- Modern chips = 2.5 billion transistors

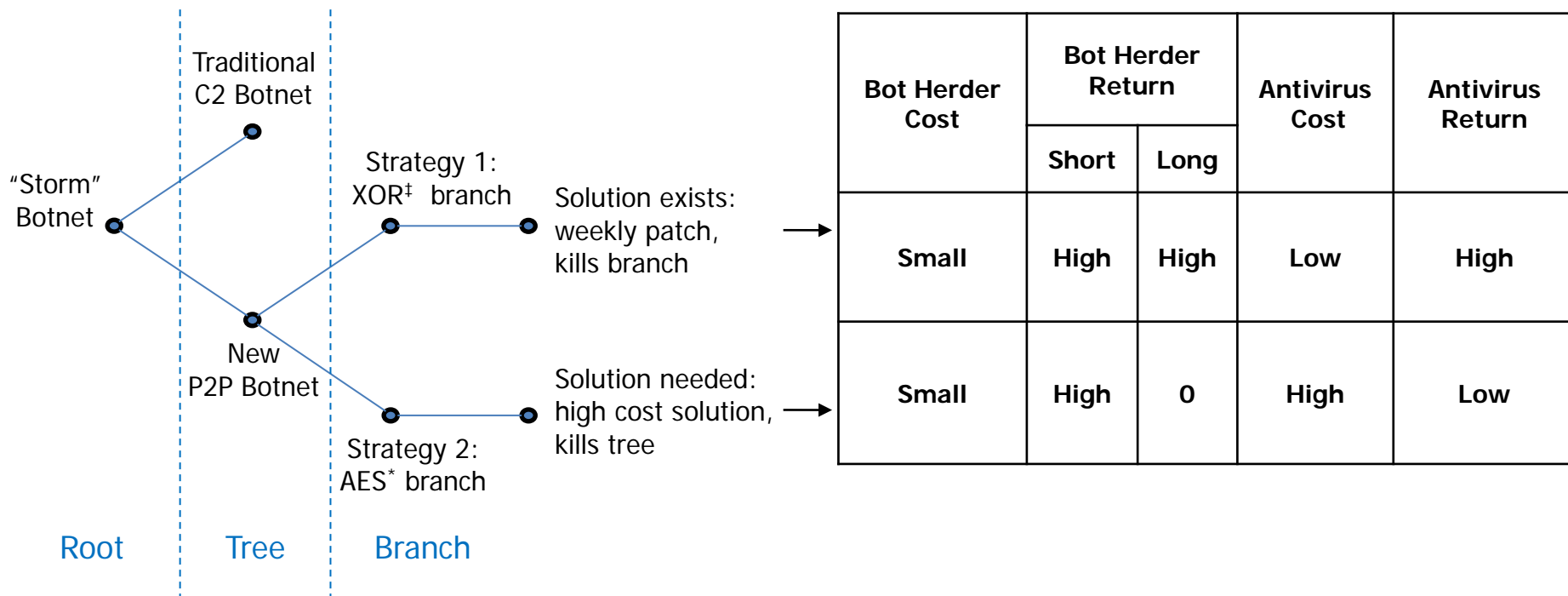
**Selective screening coupled with diplomatic sanctions
may create new solutions that are both feasible and sustainable.**



Business incentives matter...

Understanding them in the context of 'game theory' reveals the problem.

Bot Herder strategy example:



The security layering strategy and antitrust has created cross incentives that contribute to divergence.

† = "exclusive or" logical operation

* = Advanced Encryption Standard



Layering and uniformity have created unintended consequences... we are in need of new choices...

Examples:

| Belief | Approach | Example | Unintended consequence |
|---|------------------------------------|--|---|
| Defense in depth | Uniform, layered network defense | Host Based Security System | Larger attack surface introduces more areas of exploitability for attackers... Homogeneous targets that amplify effects... |
| Users are best line of defense | Operator hygiene | 15 character password | Users take short cuts and become enemy assets... |
| The interplay of technology, policy, incentives will favor better security. | Antitrust law rulings, use of COTS | Competition and independence in security software and COTS | Cross incentives that undermine security |

We need new choices that create:

Users as the best line of defense without impeding operations.
Layered defense without increasing surface area for attack.
Heterogeneous systems that are inherently manageable.



We missed it too...



...let's fix it.



Cyber Colloquium

#DARPAcyber